Colorado State University

In Situ Subsurface Radiation Monitor

Technology Need:

Characterization and monitoring of waste tanks, trenches, and cribs is an essential step at DOE sites during the remediation process and after remediation is complete. Subsurface monitoring must be performed at varying locations, depending on location and movement of contaminants of concern.

Because of its long operating history, the Hanford site contains a large assortment of waste sources, including high level waste tanks, unlined waste cribs used to contain highly radioactive waste from the plutonium-uranium extraction process, and radioactive trenches. Migration of waste from these sources should be detected promptly to plan and implement remediation. Once remediation is complete, long-term automated, unattended verification of the effectiveness of remediation is needed. Finally, verification of no-further-action decisions must be provided.

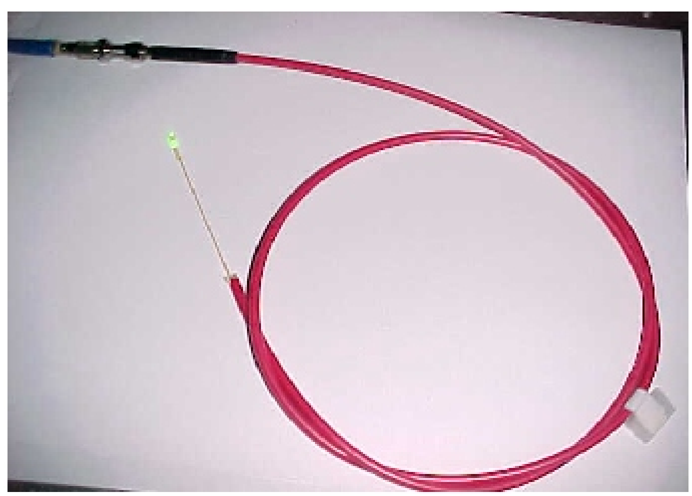
Plans for remediation of the Hanford site include stabilizing wastes on the site. Once remediation is complete, staffing requirements are assumed to be reduced. An automated, centralized, unattended monitoring system would likely be needed to collect data from a large array of monitors. The data could then be retrieved from anywhere in the world through the Internet or through more secure modes of transmission.

Technology Description:

The wastes generated by Hanford, fission products, emit both beta and gamma radiation. The in situ subsurface radiation monitor is well-suited for detection of these forms of radiation.

The in situ subsurface radiation monitor is a radioactive plume measurement and monitoring device that is cost effective, provides near real time measurements, continues to provide monitoring for many years, and does not impact and is not impacted by the environment in which it is placed. It detects both gamma radiation and mid- to high-energy beta radiation, including that emitted by ^{137}Cs, ^{99}Tc, and $^{90}Sr/^{90}Y$. The system consists of a sensor made from dosimetry grade aluminum oxide attached to a fiber optic channel to allow readout of the sensor at a remote location, thus allowing the readout of many sensors at a single location with a single reader. Two types of readers are envisioned: a portable reader that allows a technician to routinely monitor sensors individually and a stationary reader that automatically monitors many sensors in succession. By placing several probes in the ground at various depths, a radioactive contaminant plume can be detected and/or monitored. After placement, the subsurface monitor may be left in place for years, if necessary.

The sensors are made from a hypersensitive dosimeter material, aluminum oxide, that was originally developed for its thermoluminescent properties. Aluminum oxide is one of the most sensitive solid state dosimetric materials developed and is capable of measuring doses as low as 10's of µrad, or about 1 to



Sensor developed in proof-of-principle study.

2 hours of natural background radiation. Integrated doses as high as 1 krad can be measured before nonlinearities begin to occur in the response. For this application, in which the dosimeter is interrogated frequently, it is not anticipated that doses of this magnitude will be encountered. Proof of principle of a similar, smaller sensor (see figure) was demonstrated as part of a project at Oklahoma State University funded by the Oklahoma Center for the Advancement of Science & Technology (OCAST).

Benefits:

▸Long-term monitoring of radioactive waste in the subsurface.

▸Low-cost ($50 target), long life-cycle sensor portion of subsurface monitoring system.

▸Automatic, unattended monitoring with data archiving.

▸Portable, hand-held readout for monitoring during remediation.

Status and Accomplishments:

Colorado State University initiated this project by growing aluminum oxide rods and fibers and performing laboratory-scale experiments. Sensitivity testing of dosimetry-grade aluminum oxide fibers was completed. The best means for coupling the fiber optic channel to the aluminum oxide was determined. Calculations of expected dose rate as a function of radioisotope concentration and density in soils were modified to correct for material inhomogeneities. Minimum detectable dose and exposure time of the sensor as a function of soil concentration were determined. Bench testing of prototype fibers is complete.

A portable reader and sensor system have been designed and fabricated. The following tests will be completed with the portable reader and sensor in the fall of 2002: demonstrate reproducibility of gamma and beta dose measurements, test reader and probe using optical channel lengths of 30 centimeter, 3 meter, and 10 meter, test different diameters of fibers for same channel length, and demonstrate ability to discriminate between gamma and beta radiation.

Additional testing will continue, pending DOE approval, consisting of optimization of channel length, optimization of fiber diameters for the same channel length, and further demonstration of the ability to discriminate between gamma and beta radiation. On DOE approval, a demonstration pilot test will be conducted at a DOE site.

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Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 3173
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov